

OPTICAL MEDIA COMPRISING POLYARYL FILM

FIELD OF THE INVENTION

The present invention relates to an optical media comprising an high quality polymeric material film. More in particular, the present invention relates to an optical media comprising a polymeric material film having high thermal, mechanical and optical properties.

BACKGROUND OF THE INVENTION

Flat-panel displays (FPD) are becoming increasingly commonplace in today's commercial electronic devices. FPD in most of their applications are expected to be lightweight, portable, rugged, low-power and high-resolution. Displays having all these attributes will enable a wide variety of commercial applications in the future.

Most commercially available products use glass as the starting material in the display fabrication process. Glass has been widely used for several optical applications, due to its excellent characteristics, such as the transparency, the optical clarity, the high transparence in the visible light range, the high resistance to temperature and the compatibility with chemicals used in standard semiconductor manufacturing processing. Notwithstanding, due to its high weight and high brittleness, the use of glass as support in optical applications may cause problems to the final product realization. In addition, because glass is not flexible, it cannot be used in continuous processing, this leading to a relatively low final productivity.

In view of these reasons, it should be desirable to replace glass with transparent plastic films. If plastic is employed as the starting material for display manufacturing, a display that is not only lightweight and rugged but also flexible can be obtained. The realization of such a technology would have a significant impact on the display industry replacing the present sheet processes with a continuous roll-to-roll manufacturing process.

The actual process involved in the display manufacturing are designed to work with the glass support that has excellent thermo-mechanical and optical properties and that can withstand high temperature processes, solvent treatments and UV-visible light exposure without significant changes in its properties.

Typical display manufacturing processes, such as those to manufacture liquid crystal display (LCD) and organic light emitting diode (OLED), having an active matrix (AM) or a passive matrix (PM), use the glass as support, at present. The glass is the starting point for the manufacturing process which comprises the coating of different functional layers which can vary according to the desired kind of display. Metals or metal oxides such as silicon or indium tin oxide (ITO) are coated on the glass by sputtering or vacuum deposition, for instance, and then treated by thermal, laser or chemical treatment

to form the driving circuit of the display. In case of high performance driving circuits (TFT, for example) these processes are carried out on glass at a temperature of about 600°C. Recent developments have reduced this temperature to about 250-350°C by laser technique.

Most of the plastic materials available in the market, in spite of having optical properties that match the requirements for applications as support for display, have glass transition temperature lower than 240°C and this make them useless in the above mentioned processes. US 5,817,550 and US 5,856,858 describe a method for the formation of thin film transistors on low-temperature plastic substrates. The methods includes the substrate to be coated on both sides by 0.1-5.0 microns of SiO₂ as first step in the manufacturing process. This allow the film to withstand the high temperature required by the TFT assembly. N.D. Young et Al., Low Temperature Poly-Si on Glass and Polymer Substrates, ASIA DISPLAY Workshop, 1998 describe the fabrication of polycrystalline silicon TFT on polymer supports. Thermal stability up to 250-350°C is required to the polymer substrate in order to obtain TFT's circuits with good properties, such as high mechanical properties and low thermal shrinkage rate to guarantee a good stability and self-sustaining properties during the construction processes. Further, protective layers are needed to increase the resistance to chemicals and solvents during displays manufacturing steps.

High mechanical properties are needed to obtain a self-supporting film during the device assembly and its use. Eventually, a good resistance to the UV-visible light exposure without remarkable degradation (support embrittlement and colour changes) is required to withstand the process steps where UV sources can be used and to prevent degradation in sunlight environment applications.

Other problems are related to the stability during time of the displays. Active materials used in displays are extremely sensitive to oxidation and then to the presence of oxygen and moisture in the internal side of the displays. High barrier properties against said oxygen and moisture The glass accordingly provides a suitable impermeability level for this kind of applications, while, on the contrary, the plastic generally is too permeable. This problem, together with the resistance to chemicals and scratches is solved by adding suitable functional layers to the surface of the plastic film. Most common anti-scratches layers and barrier layers are based on UV-photocurable materials and this makes the substrate UV resistance one of the main required properties for the potential plastic support for optical devices. US 6,358,570, US 6,268,695 and US 6,413,645 disclose barrier layers coated on the plastic film. The main application is as plastic support for displays where high barrier properties to moisture and oxygen are required. The barrier structure is a multilayered composition of curable resins and inorganic compounds. The resins can be cured by UV radiation.

Several patents and patent applications describe fluorene polyester materials for electrical applications.

US Patent 3,546,165 describes thermally stable polyesters of various gem-bisphenols and dicarboxylic acids. Included are polyesters of 9,9-bis(4-hydroxyphenyl)fluorene with 100% isophthalic acids and 9,9-bis(4-hydroxyphenyl)fluorene with 80%wt isophthalic acid and 20%wt terephthalic acids. Softening temperature of 360°C for both these polymers are reported. UV stability and mechanical properties have not been evaluated.

US Patent 4,387,209 describes polyesters made by reacting 9,9-bis-(4-hydroxyphenyl)-fluorene with at least one member of the group consisting of isophthalic or terephthalic acid and using an interfacial polymerization process. The polyester inherent viscosity strongly depends upon the monomer purity and relatively small variations in purity of the diphenol monomer may cause large deviations in the inherent viscosity values. Polyester films are described to be used in the electrical insulation field, and neither data on optical properties nor possible applications are reported.

US 4,967,306 discloses a 9,9-bis-(4-hydroxyphenyl)-fluorene/isophthalic and terephthalic acid polyester which contains a very low level of low molecular weight oligomers and has a tensile strength, elongation, chemical resistance, temperature stability, ultraviolet resistance and vacuum stability higher than the known in the art co-polymers containing low molecular weight oligomeric species. It is disclosed therein that films containing small amounts of oligomer will yellow or degrade upon limited exposure to ultraviolet radiation.

The resin obtained from the polyarylate composed of 9,9-bis-(3-methyl-4-hydroxyphenyl)-fluorene and isophthalic acid reported in Journal of Applied Polymer Science, Vol. 29, p. 35 to 43 (1984) results to be too fragile and has insufficient abrasion resistance and low film quality.

Japanese Patent Application No. 09-071,640 discloses a resin composed of (a) an aromatic dicarboxylic acid, (b) a specific amount of a substituted 9,9-bis-(4-hydroxyphenyl)-fluorene and (c) an aliphatic glycol; said resin is utilized in optical materials for its good transparency and heat resistance.

US 4,810,771 discloses polyesters made of mono-ortho substituted bisphenols, and a blend of isophthalic and terephthalic acid.

EP Patent Application 943,640 describes a film prepared with polyarylates synthesized using bisphenolfluorenes mono- and bi-substituted in the ortho position with alkyl (C1-C4) groups. Such polyarylates have a better stability to ultraviolet radiation.

9,9-bis(3,5-dibromo-4-hydroxyphenyl)-fluorene bisphenol monomer derived polyarylates have been disclosed in PCT Patent Application No. WO 00-33,949 as gas-separation membranes.

In US 5,007,945, there is described a polyarylate class obtained from dicarboxylic acid chlorides and cardo bisphenols having halo-substituents on all ortho positions of the phenol groups, which is used to separate one or more components of a gas mixture. Such patents describe gas-separation membranes, but do not mention optical films consisting of such polymers.

The present invention describe a plastic film suitable for optical applications and more preferably as a display support, able to withstand to the present manufacturing processes and to the enviromental conditions during its use. Also, the use of a flexible plastic support will allow to introduce roll-to-roll technologies in the manufacturing of displays.

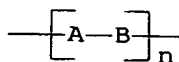
SUMMARY OF THE INVENTION

An optical media comprising a polymeric material film, characterized in that said polymeric material is a polyester obtained from a 9,9-bis(4-hydroxyphenyl)fluorene derivative and a mixture of terephthalic acid and isophthalic acid derivatives, said polymeric material having a glass transition temperature higher than 315°C and a yellowing coefficient Yc lower than 0.0060.

DETAILED DESCRIPTION OF THE INVENTION

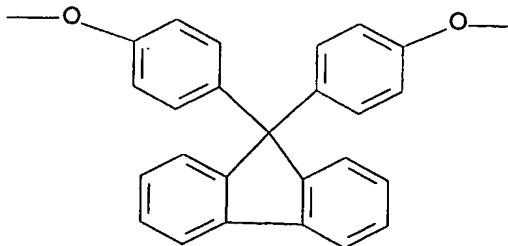
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The polyester useful in the present invention can be represented by the general structure:



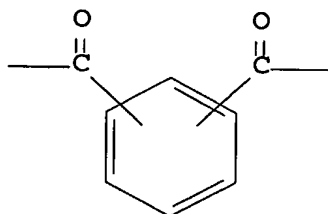
wherein

A represents one or more different 9,9-bis(4-hydroxyphenyl)fluorene group having general formula (I):



formula (I)

B represents one or more different dicarboxy groups having the formula:

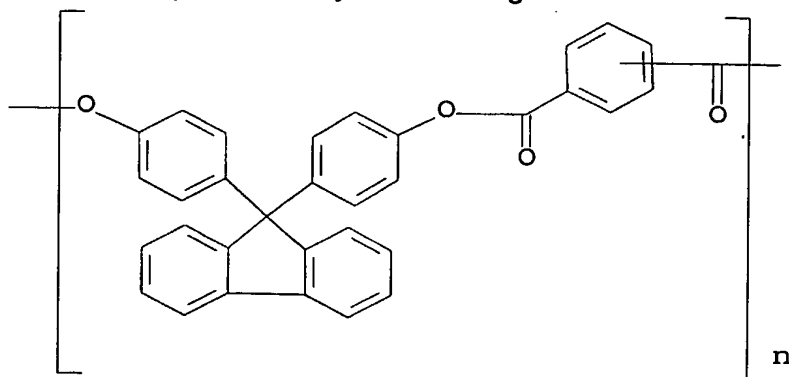


formula (II)

and

n is the number of the repeating units which build up the polymer and is a positive integer higher than 20.

Preferably, the present invention refers to an optical film comprising one or more polyesters represented by the following structure:



wherein n is a positive integer higher than 20. Still more preferably, the present invention refers to an optical film comprising a polyester obtained from at least two different polymerizable units represented by the 9,9-bis-(4-hydroxyphenyl)-fluorene group of general formula (I) and from a mixture of isophthalic acid and terephthalic acid. More preferably, the mixture of isophthalic acid and terephthalic acid comprises from 20 to 80% by weight of an isophthalic group and from 80 to 20% by weight of a terephthalic group. Most preferably, the mixture of isophthalic acid and terephthalic acid comprises from 30 to 70% by weight of an isophthalic group and from 70 to 30% by weight of a terephthalic group.

When in the present invention the term "group" is used to describe a chemical compound or substituent, the described chemical material comprises the group, ring and base residue and that group, ring or residue with conventional substituents. When on the contrary the term "unit" is used, on the unsubstituted chemical material is intended to be included. For instance, the term "alkyl group" comprises not only those alkyl units, such as methyl, ethyl, butyl, octyl, etc., but also those units bearing substituents such as halogen, nitrile, hydroxy, nitro, amino, carboxy, etc. The term "alkyl unit" on the contrary comprises only methyl, ethyl, cyclohexyl, etc.

The polymeric material useful in the present invention has excellent mechanical and thermal properties, a high T_g and is less subject to yellowing upon exposure to UV-visible light sources. More in particular, the polymeric material shows a glass transition temperature higher than 315°C, more preferably higher than 325°C, and most preferably higher than 335°C and a yellowing coefficient Y_c lower than 0.0060, more preferably lower than 0.0055, and most preferably lower than 0.0050.

The above mentioned properties allows the polymeric material of the present invention to be used as substitute of glass support in the manufacturing of a number of optical media known in the art, such as liquid crystal displays, electroluminescent displays, organic light-emitting diode displays, and the like. This allows to obtain more flexible and resistant displays than those conventionally manufactured using glass supports. Also, the use of the polymeric material of the present invention allows to use roll-to-roll technologies in the manufacturing of displays.

EXAMPLES

Sample films were obtained by taking compound A and polymerizing it with the interfacial polycondensation technique as described in EP patent 396,418, utilizing a mixture of terephthalic acid (TPA) and isophthalic acid (IPA) as reported in the following Table 1.

TABLE 1

Sample film	% TPA	% IPA
1 (comparison)	5	95
2 (comparison)	10	90
3 (invention)	30	70
4 (invention)	50	50
5 (invention)	70	30
6 (comparison)	90	10
7 (comparison)	95	5

The so-obtained polymer was coated with the solvent coating technique using a 10% weight methylene chloride solution of the polymer. The resulting film having a thickness of 100 µm was then dried for 3 hours at a temperature of 25°C, gradually increasing the temperature up to a maximum of 160°C. Samples films 1 to 7 were then subjected to UV ageing tests by using a Fusion F300 Lamp System produced by Fusion UV Systems Inc. equipped with H and D bulbs and a 2 mm thick glass pyrex filter interposed between the UV source and the samples.

Sample film yellowing was measured by comparing their absorbance, before and after the expositions, at the selected wavelength of 400nm which was identified as the most significant (blue light absorption). Optical absorbance was measured by a Perkin-Elmer Lambda 2 spectrophotometer working in the 320-500 nm range. The Yellowing Coefficient (Yc) is defined as the ratio of the averaged variation of absorbance of a polymeric film exposed to a UV radiation source and the effective exposure energy. The maximum exposure energy employed was up to 5.0 J/cm². The lower is the Yc value, the best is the result. The results are summarized in the following Table 2.

The glass transition temperature values (Tg) of the sample films 1 to 7 were determined by means of a Perkin-Elmer DSC-4 differential scanning calorimeter, by following a heating ramp of 10°C/min. starting from a temperature of 50°C up to 400°C under a continuous nitrogen stream. The results are summarized in the following Table 2.

TABLE 2

Sample	Fusion System H bulb Yc	Fusion System D bulb Yc	Glass Transition Temperature Tg (°C)
1 (comparison)	0.00328	0.00299	306
2 (comparison)	0.00327	0.00316	308
3 (invention)	0.00375	0.00343	318
4 (invention)	0.00446	0.00450	326
5 (invention)	0.00522	0.00541	348
6 (comparison)	0.00615	0.00612	363
7 (comparison)	0.00608	0.00664	361

Table 2 clearly shows that only Sample films 3 to 5 are useful in the present invention to obtain an optical media having contemporaneously good yellowing coefficient values (Yc lower than 0.0060) and good glass transition temperature values (Tg higher than 315°C). On the contrary, comparison Sample films 1 to 2 showed glass transition temperature values too low and comparison Sample films 6 to 7 showed yellowing coefficient values too high.

While a particular embodiment has been set forth to exemplify and explain the principles of the invention, such are not intended to be limiting. Modifications and changes may become apparent to those skilled in the art, and it is intended that the invention be limited only by the scope of the appended claims.